

STATE OF ALASKA

Jay S. Hammond, Governor



Annual Performance Report for

COHO SALMON STUDIES IN
THE RESURRECTION BAY AREA

by

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RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

Project No.: F-9-11

Study No.: G-II Study Title: SPORT FISH STUDIES

Job No.: G-II-A Job Title: Coho Salmon Studies in the Resurrection Bay Area

Period Covered: July 1, 1978 to June 30, 1979.

ABSTRACT

Bear Lake was restocked with 225,800 age 0.0 coho salmon, *Oncorhynchus kisutch* (Walbaum), fingerlings on June 20-21, 1978 to maintain smolt production.

The Bear Creek weir downstream migrant trap was operated continuously from May 16 through September 15. A total of 97,814 age 1.0, 2.0, and 3.0 coho smolts were enumerated. Age 1.0 smolt survival of the 1977 Bear Lake fingerling plant was 35.6 percent.

Bear Lake's smolt out-migration timing and abundance, age and size compositions, and condition factors are presented. Bear Creek water temperatures and stream flows corresponding to migration peaks and durations are also given. The slight but continuing decline in Bear Lake's total smolt biomass (kilograms) production, possibly related to reduced nutrient phosphorous levels in the water column, is discussed.

The Resurrection Bay creel census (July 8-September 10) indicated an estimated 15,550 coho were harvested by 22,291 man-days of sport effort. The mean seasonal catch per angler hour was 0.126 coho. Enhanced adult coho production contributed 43.3 percent to the sport harvest. Most (51.3 percent) survived from 100,450 age 1.0, hatchery-reared, RV marked smolts planted in Seward Lagoon in May, 1977. An additional 30.4 percent resulted from 99,844 Bear Lake smolts (25.0 percent marked Ad-LV) and 35,100 age 1.0, Ad-RV marked hatchery smolts released in lower Bear Creek in 1977. The remaining 18.3 percent returned from 35,100 age 1.0, LV marked hatchery smolts stocked in Grouse Lake in May, 1977. Marked immature coho contributed an additional 0.4 percent to the sport fishery. These juveniles resulted from Ad-CWT marked segments of hatchery-reared smolt releases stocked in the above waters in late May and early June, 1978.

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through October 31. The adult coho upstream migration to the trap extended from September 2 to October 31 and consisted of 2,959 adults and

130 jacks. Adults were comprised of 548 Ad-RV, 147 Ad-LV, 127 Ad, 12 LV, 8 RV, and 2,117 unmarked coho. An estimated 156 Ad-RV, 35 Ad-LV, 25 Ad, 81 LV, 20 RV and 157 unmarked coho spawned in lower Bear Creek. Most (82.3 percent) of the jacks returned from 27,156 age 1.0 (1976 brood, Bear Lake origin) Ad-CWT, hatchery-reared smolts released below the weir in 1978. Total smolt-to-adult survivals per release lot were 3.8 percent (Bear Lake), 4.9 percent (Bear Creek), 6.0 percent (Grouse Lake), and 7.7 percent (Seward Lagoon). Bear Lake smolts released unmarked past the weir in 1977 realized nearly five times the adult survival of their marked counterparts. Total survivals of Bear Lake smolt out-migrations (1973-1977), Bear Creek (1969-1977), and Seward Lagoon (1968-1977) smolt releases are summarized. The overall catch-to-escapement ratio of marked Seward Lagoon, Grouse and Bear lakes adult coho returns was 0.82:1. The adult male-to-female sex ratio was 1.6:1 in the Bear Creek escapement. An estimated 2,180,760 fertilized eggs were artificially spawned from 496 females and 121 males from the Bear Lake return.

Data on the timing and abundance of other fish species ascending and descending Bear Creek to the weir are presented. Minimum coho escapements in seven local index streams are reviewed.

BACKGROUND

Wild coho salmon production in Resurrection Bay is believed to be directly affected by the extreme fluctuations in stream flows and water temperatures characteristic of its drainage streams. Since 1961, the Resurrection Bay coho sport fishery has become the largest marine sport fishery for this species in Alaska. Therefore, it became imperative to stabilize or improve Resurrection Bay coho production to satisfy the growing angler demand in the fishery. Figure 1 shows the Resurrection Bay drainage, and Table 1 lists the anadromous fish species indigenous in its tributaries.

Bear Lake, located seven miles north of Seward, was chosen for coho rearing because it is the largest (180 hectares or 445 acres) stable body of clear fresh water in the Resurrection River drainage, and is accessible by road. It was determined after a survey in 1962 that Bear Lake should be rehabilitated with rotenone to eradicate all predator- and competitor-fish species inhabiting the lake. Without predation and interspecific competition, it was believed that Bear Lake could then produce a high sustained smolt yield from annual coho fingerling plants.

Pre-rehabilitation species abundances were measured by a temporary weir situated at the Bear Creek-Salmon Creek confluence from 1961 to 1964. Upstream migrations averaged 921 adult coho, (1961-1964); 4,801 adult sockeye salmon, (1961-1965); and 10,543 Dolly Varden, (1961-1962). Downstream migrations in 1962-1963 averaged 7,933 coho smolts, 51,232 sockeye smolts, and 17,838 Dolly Varden. Though threespine stickleback downstream migrations were not estimated at the weir, beach seine sampling indicated that this species was abundant in Bear Lake.

Bear Lake was rehabilitated with powdered rotenone at 1.0 mg/l (5% level) on August 26, 1963. A 1.5-meter (5-foot) high dam was erected at the outlet to contain the treated water until detoxification and to prevent

FIGURE 1.

RESURRECTION BAY WATERSHED

- | | |
|------------------------|--------------------|
| 1. Salmon Creek | 2. Bear Creek |
| 3. Grouse Creek | 4. Bear Creek Weir |
| 5. Airport Creek | 6. Jap Creek |
| 7. Dairy Creek | 8. Seward Highway |
| 9. Grouse Lake | 10. Seward |
| 11. Resurrection River | |
| 12. Mayor Creek | |
| 13. Small Boat Harbor | |
| 14. Seward Lagoon | |
| 15. Clear Creek | |
| 16. Box Canyon Creek | |

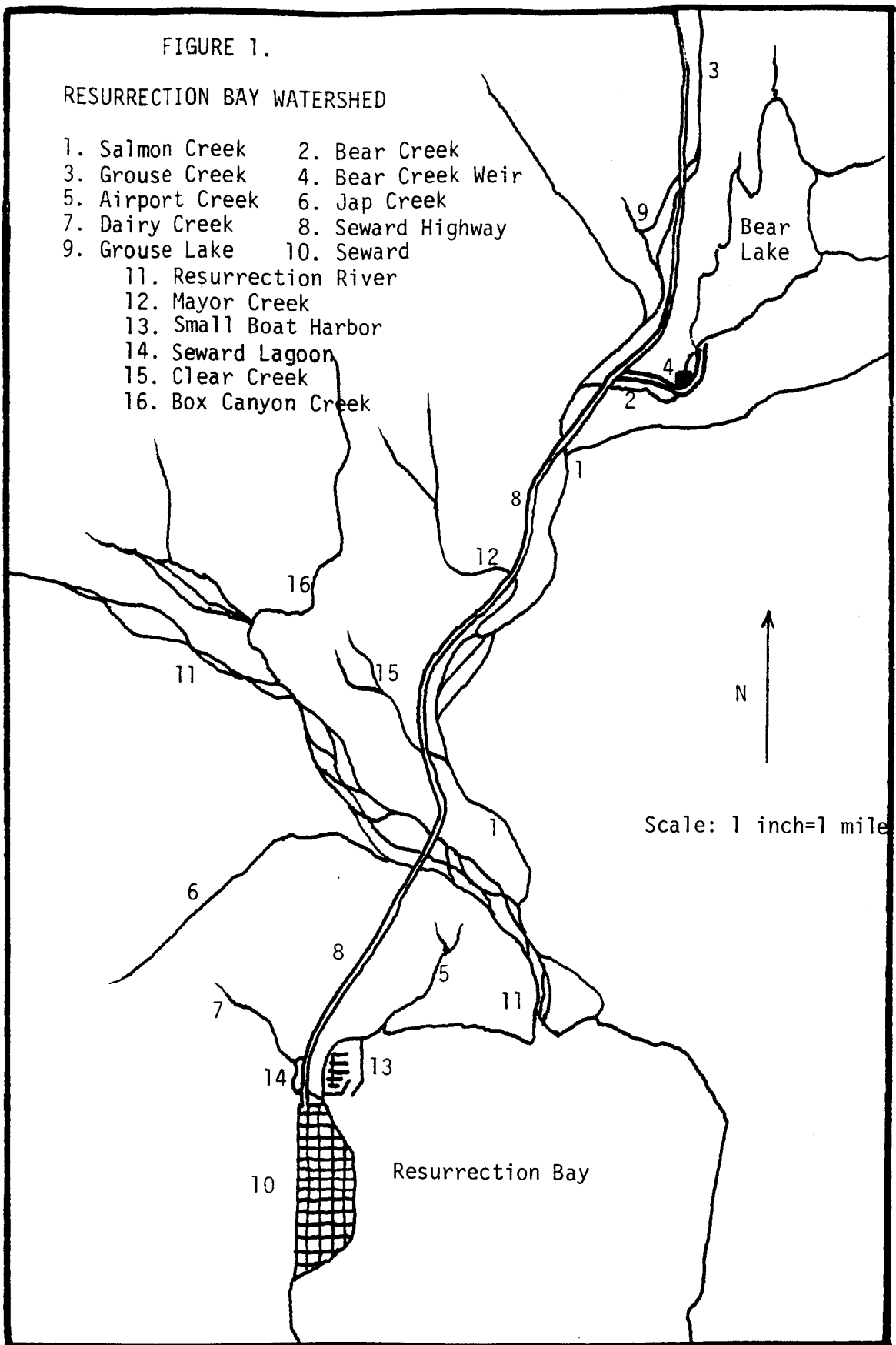


Table 1. Checklist of Fish Species Present in the Resurrection Bay
Drainage.

Common Name	Scientific Name and Author
Dolly Varden	<i>Salvelinus malma</i> (Walbaum)
Rainbow-steelhead trout	<i>Salmo gairdneri</i> Richardson
Sockeye salmon	<i>Oncorhynchus nerka</i> (Walbaum)
Coho salmon	<i>Oncorhynchus kisutch</i> (Walbaum)
Chum salmon	<i>Oncorhynchus keta</i> (Walbaum)
Chinook salmon	<i>Oncorhynchus tshawytscha</i> (Walbaum)
Pink salmon	<i>Oncorhynchus gorbuscha</i> (Walbaum)
Threespine stickleback	<i>Gasterosteus aculeatus</i> Linnaeus

subsequent immigration of undesirable species. Bear Lake detoxified by October 17, 52 days after the water was treated, and received its first annual fingerling plant that winter through the ice. All fingerling plants except the 1966 release were fin-marked at Fire Lake Hatchery to facilitate smolt survival evaluation.

The Good Friday earthquake on March 27, 1964 destroyed the outlet dam, which washed out completely on May 25. This allowed unobstructed entry of all fish ascending Bear Creek into Bear Lake until June 15, when the barrier was repaired. A permanent weir was constructed 533.4 meters (1,750 feet) downstream from the outlet to assess Bear Lake's coho smolt production and returning adult migrations.

Bear Lake became reinfested with threespine sticklebacks. It is not known whether this was due to insufficient rotenone treatment or the destruction of the outlet barrier. Also, Dolly Varden were able to negotiate the weir during fall flood levels and immigrate into the lake on most years.

Before rapid expansion of the stickleback population occurred, Bear Lake's coho and sockeye smolt production increased several fold as a result of favorable rearing conditions from 1964 to 1966. Coho smolt biomass (weight) production attained 4.2 kilograms for each kilogram of fingerlings planted in 1964. Smolt age structures changed from predominantly age 2.0 to age 1.0 with growth exceeding that of former age 2.0 smolts. Smolt survival from stocked coho fingerlings reached 43.5% of the 1964 and 48.1% of the 1965 plants. Had sufficient coho fingerlings been available for stocking Bear Lake at desired densities in 1963-1965, coho smolt production would have been considerably higher. Bear Lake's enhanced smolt production increased pre-rehabilitation abundances of adult sockeye by 11 times and coho by 3.5 times.

Bear Lake's high smolt production was short lived, however, due to the sticklebacks' rapid takeover of the rearing environment beginning in 1967. Smolt age structures reverted to age 2.0 dominance, growth rates declined, and fingerling-to-smolt survivals lowered. Coho fingerling plants were terminated after 1967 because smolt production was obviously dropping below pre-rehabilitation levels. By 1968, threespine sticklebacks had already reached pre-rehabilitation abundance in the lake.

In 1969, it was decided to rehabilitate Bear Lake again. Stickleback population sampling in 1970 showed that this species inhabited all areas and depths in Bear Lake. Bear Creek weir was reconstructed in 1969 and made entirely fish-tight by removing the sloping upstream fence and adding three permanent, perforated plate screens above the upstream migrant trap.

Bear Lake was rehabilitated again in 1971, and lake treatment was conducted essentially the same as in 1963 except that 100% emulsified instead of powered rotenone was used. Overall treatment level was 1.6 mg/l rotenone at 5% concentration. Caged live fish suspended from surface to bottom, 12 to 18 meters (40 to 60 feet), were all dead within one week. Population sampling two days following rehabilitation showed that threespine sticklebacks comprised 98.8% of the total sample (n = 9,065) collected

randomly on and around Bear Lake. From this it was concluded that obtaining less than total lake rehabilitation in 1963 ultimately resulted in lower-than-normal salmon production in Bear Lake over the long term.

Bear Lake remained toxic through the winter of 1971-1972, and finally detoxified shortly after spring overturn. Annual coho fingerling plants in Bear Lake resumed in June 1972 at desired stocking densities. Resultant smolts were enumerated, sampled weekly for age and size composition as well as condition factor, and fin-marked for recognition in the fishery before being released at Bear Creek weir. No threespine sticklebacks have been detected in Bear Lake during fall population sampling of juvenile coho by electrofishing or at Bear Creek weir since the 1971 rehabilitation.

Bear Lake was stocked from 1972-1975 at densities ranging from 2,461 to 2,503 fingerlings per surface hectare. The cumulative effect in just three years resulted in critically overstocking Bear Lake's coho rearing habitat.

Intense intraspecific competition among fingerlings evidently depressed growth rates, lowered survivals and extended rearing duration to smoltification. Mean seasonal condition factors of all smolts sampled each year were observed to drop from 0.98 (1973) to 0.90 (1974) to 0.89 (1975). The percentage of fingerling plants resulting in age 1.0 smolts also decreased from 17.2% (1973) to 14.5% (1974) to 3.0% (1975). Similarly, biomass ratios of age 1.0 smolts produced per fingerling release declined abruptly from 8.9:1 (1973) to 4.9:1 (1974) to 0.4:1 (1975).

Increased stress from overcrowding apparently led to greater susceptibility (lowered resistance) of rearing fingerlings to natural diseases in Bear Lake. Though the 1975 smolt out-migration (168,036 smolts) was the largest ever recorded for Bear Lake, over 91% were age 2.0 smolts in relatively poor condition. Nearly 13% of the smolt run died from "eye fluke", *Diplostomulum spathaceum*, and fungus, *Saprolegnia* sp., diseases at the weir. Only 1.1% of the 143,589 smolts released in 1975 survived to return as adults in 1976.

A downward adjustment in Bear Lake's fingerling stocking density was therefore clearly indicated from these findings. Bear Lake has been stocked since 1976 at only 1,247 to 1,265 per hectare, or approximately one-half previous levels, to enhance fingerling growth and survival to smolts. The following report presents the findings and discusses the results of this reduced fingerling stocking density on Bear Lake's coho salmon production.

RECOMMENDATIONS

1. The present objectives of the study should be retained.
2. A permanent coho adult trapping-holding facility should be constructed in Seward Lagoon.

3. The 1980 stocking density of coho fingerlings in Bear Lake should be adjusted according to emigrating smolt and residual fingerling abundance, age composition and condition factor in 1979.
4. Marking of Bear Lake smolt out-migrations should be discontinued.
5. Baseline data on Bear Lake's physical, chemical, and biological parameters should be collected preliminary to artificial fertilization experiments.

OBJECTIVES

1. To determine the distribution, abundance, and timing of outmigrant and adult coho salmon in the Resurrection Bay area.
2. To determine the age and size composition of outmigrant and adult coho salmon populations in selected tributaries.
3. To determine the sport harvest and fishing mortality of coho salmon in Resurrection Bay.
4. To determine the methods and means of increasing or extending the freshwater spawning and rearing areas of the watershed, and mitigating freshwater mortality.
5. To provide recommendations for the management of coho salmon in these waters and direct the course of future studies.

TECHNIQUES USED

The timing and abundance of sockeye and coho salmon smolts emigrating from Bear Lake downstream to Bear Creek weir were determined by enumerating these fish at the downstream migrant trap. Weir location and description of the downstream trapping facilities were presented by Logan (1969). The timing and abundance of adult sockeye and coho salmon were measured by enumerating these fish at the weir's upstream migrant trap. Adult trapping facilities, rebuilt in 1969 and modified in 1970, were described by McHenry (1971). Bear Creek water temperatures and stream flows were recorded daily at the weir to subsequently correlate these physical parameters with the onset, peak, and termination of migrations.

Age and size composition of Bear Lake sockeye and coho smolt populations were determined by weekly sampling at the weir. Age compositions of Bear Lake sockeye smolt and adult migrations, Bear Lake coho smolt and Resurrection Bay adult coho populations were determined by examining representative scale impressions on 0.02-inch cellulose acetate with a Bruning model 200 microfiche. Smolt abundance per age group was calculated

by extrapolating the age composition, as determined in weekly scale sample analysis, to the total number of smolts emigrating during those weekly periods. Age composition of the Bear Lake unmarked coho return was not sampled because wild coho returning from natural production below the weir were indistinguishable from Bear Lake smolts released unmarked in 1977. Size composition of Bear Lake's sockeye and coho escapements were determined by representatively sampling the migrations for fork length, weight and sex. All fish sampled were anesthetized in a 50 mg/l solution of MS-222 (Tricaine methanesulfonate) to facilitate handling and minimize mortality.

Resurrection Bay coho sport harvest and angler effort (man-days) were measured by a stratified, random creel census conducted at the Seward small boat harbor. Sampling design and interview method were nearly identical to that described by Logan (1966). The average number and percentage of sport fishing boats returning to the Seward small boat harbor were determined for each of three 3.5-hour sampling periods extending from 11:30 a.m. to 10 p.m. Returning boats were not sampled from 8 a.m. to 11:30 a.m. because only 11.6% of the weekend and 14.3% of the weekday sport craft returned during this period in the three years sampled (1964-1966). The mean number of boats returning during this morning period was extrapolated using the above percentages. These estimates were then added to those determined for the three periods sampled to estimate total daily boats. Total sport fishing effort and harvest were estimated for the season by multiplying weekly means (anglers/boat and salmon/boat) times total returning boats for all weekends and weekdays included in the creel census period. Fishing mortality and catch-to-escapement ratio of marked (fin-clipped) adult coho were determined by extrapolating the marked coho catch observed during creel census and by recording marked coho in the Bear Lake, Grouse Creek, and Seward Lagoon spawning escapements. Coho taken in the shore fishery after the boat creel census terminated were considered "escapement" for the Resurrection Bay catch-to-escapement ratio determination.

An index to Resurrection Bay coho escapement abundance was measured by conducting weekly foot surveys on seven local index streams throughout immigration until peak of spawning terminated. All carcasses were examined for clipped fins, then sexed and mutilated to preclude recounting on subsequent surveys.

Evaluation of Bear Lake's rehabilitated rearing environment was continued by measuring the abundance, growth, and condition of smolts surviving from the 1975, 1976, and 1977 coho fingerling plants. Smolt biomass (kilograms) production was calculated by multiplying the seasonal mean smolt weight (grams) per age group by the total number of smolts emigrating in each age group in 1978.

FINDINGS

Results

The findings presented are the result of the 1978-1979 research segment of the project. For a description of the Resurrection Bay drainage and past information collected on the project, see Logan (1962-1969) and McHenry (1970-1978).

Bear Lake Coho Smolt Migration:

The Bear Creek weir downstream migrant trap was operated continuously from May 16 through September 15 when the trap was removed due to cessation of the Bear Lake smolt emigration. Abundance and timing of the coho salmon smolt out-migration are shown in Table 2. All fingerlings were retained above the weir or restocked in Bear Lake if sufficiently abundant in the trap to warrant hauling by truck.

The out-migration to the downstream trap totaled 97,814 smolts. Trap mortality claimed only 155 smolts (0.2% of the out-migration). A total of 97,659 live smolts were released downstream. A predetermined 25% of the out-migration received a right ventral (RV) fin-clip for recognition in the 1979 Resurrection Bay sport fishery and upon return to Bear Creek. Table 3 shows the number and percentage of smolts marked and sampled for age, size and condition factor in each weekly period.

Smolt emigration began on May 17, peaked (50% of out-migration) by June 18, and terminated September 15. The highest daily count occurred on June 18 when 9,073 (9.3% of the total run) were enumerated from the trap.

Mean stream temperatures when smolt emigration began, peaked, and terminated were 4.7°C (40.5°F), 10.6°C (51.0°F), and 11.4°C (52.5°F), respectively. Bear Creek stream flows ranged from 10 to 65 cfs during this period.

The smolt out-migration was comprised of 82.8% (81,014) age 1.0, 16.8% (16,457) age 2.0, and 0.4% (343) age 3.0 smolts. Tables 4, 5 and 6 present the mean fork length, weight, condition factor and relative percentage of age 1.0, 2.0, and 3.0 smolts in the weekly samples. Table 7 shows the weekly and seasonal smolt abundance per age group. An overall 2.5% (2,419 smolts) was representatively sampled during emigration (Table 3). An estimated 80,886 age 1.0, 16,431 age 2.0, and 342 age 3.0 live smolts were released downstream.

Age 1.0 and 3.0 smolt migrations peaked during the week of June 17-23 when Bear Creek water temperatures averaged 10.9°C (51.6°F). Age 2.0 smolts peaked in the previous week at stream temperatures averaging 7.8°C (46.1°F). Approximately 69% of the Bear Lake smolt out-migration had emigrated to the weir during the first week of 10°C (50°F) mean water temperature recorded in Bear Creek. About 65% (+3%) of each Bear Lake smolt migration since 1973 has been processed through the downstream trap during this period. Bear Lake's total coho smolt out-migration, therefore, can be roughly predicted on any given year by estimating that 65% of the smolt population has reached the weir by the end of the week.

Table 2. Bear Lake Coho Salmon Smolts Enumerated at Bear Creek Weir
by Weekly Periods, 1978.

Weekly Periods	Number of Smolts		Total
	Live	Dead	
May 13 - May 19	2	3	5
May 20 - May 26	16		16
May 27 - June 2	136	2	138
June 3 - June 9	10,127	6	10,133
June 10 - June 16	33,651	42	33,693
June 17 - June 23	23,673	18	23,691
June 26 - June 30	17,084	13	17,097
July 1 - July 7	9,174	41	9,215
July 8 - July 14	1,739	10	1,749
July 15 - July 21	965	1	966
July 22 - July 28	618		618
July 29 - August 4	172		172
August 5 - August 11	8		8
August 12 - August 18	82		82
August 19 - August 25	39		39
August 26 - September 1	2		2
September 2 - September 8			
September 9 - September 15	<u>171</u>	<u>19</u>	<u>190</u>
Total	97,659	155	97,814

Table 3. Bear Lake Coho Salmon Smolts Marked and Sampled at Bear Creek Weir by Weekly Periods, 1978.

Weekly Periods	Number of Live Smolts	Number Smolts Fin Clipped	Percent of Weekly Migration*	Number Smolts Sampled	Percent of Weekly Migration*
May 13 - 19	2	1	50.0		
May 20 - 26	16				
May 27 - June 2	136	22	16.2	1	0.7
June 3 - 9	10,127	2,297	22.7	200	2.0
June 10 - 16	33,651	7,324	21.8	700	2.1
June 17 - 23	23,673	6,907	29.2	780	3.3
June 24 - 30	17,084	4,108	24.0	300	1.8
July 1 - 7	9,174	2,751	30.0	356	3.9
July 8 - 14	1,739	527	30.3	44	2.5
July 15 - 21	965	241	25.0	23	2.4
July 22 - 28	618	158	25.6	15	2.4
July 29 - August 4	172	26	15.1		
August 5 - 11	8				
August 12 - 18	82				
August 19 - 25	39				
August 26 - Sept. 1	2	2	100.0		
Sept. 2 - 8					
Sept. 9 - 15	171	63	36.8		
Total	97,659	24,427	25.0	2,419**	2.5

* Minus the 155 smolts expiring from trap mortality.

** Sixteen smolts of this sample were not assigned to an age group due to their regenerate or unreadable scale samples.

Table 4. Mean Fork Length, Weight and Condition Factor of Age 1.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1978.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
June 3 - 9	139	70.2	121.1 \pm 7.9	17.63 \pm 3.19	0.99
June 10 - 16	564	80.9	118.8 \pm 7.9	16.15 \pm 3.03	0.96
June 17 - 23	654	84.4	120.0 \pm 8.2	16.89 \pm 3.24	0.98
June 24 - 30	253	84.6	122.7 \pm 8.0	17.61 \pm 3.15	0.95
July 1 - 7	326	92.6	125.6 \pm 8.4	19.50 \pm 3.89	0.98
July 8 - 14	41	93.2	130.8 \pm 6.2	23.01 \pm 3.53	1.03
July 15 - 21	22	95.7	137.0 \pm 9.9	25.99 \pm 5.28	1.01
July 22 - 28	14	93.3	140.1 \pm 10.5	30.18 \pm 7.35	1.10

* $K = \frac{W \times 10^5}{L^3}$, where W = mean weight in grams, and L = mean fork length in millimeters.

Table 5. Mean Fork Length, Weight and Condition Factor of Age 2.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1978.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)
June 3 - 9	56	28.3	137.9 \pm 10.7	26.90 \pm 6.51	1.03
June 10 - 16	133	19.1	134.8 \pm 9.5	24.12 \pm 5.29	0.98
June 17 - 23	118	15.2	138.3 \pm 9.2	26.05 \pm 5.21	0.98
June 24 - 30	45	15.1	136.4 \pm 7.2	24.40 \pm 3.73	0.96
July 1 - 7	26	7.4	149.5 \pm 11.8	31.53 \pm 7.35	0.94
July 8 - 14	3	6.8	147.0 \pm 6.1	32.27 \pm 4.06	1.02
July 15 - 21	1	4.3	156	37.5	0.99
July 22 - 28					

Table 6. Mean Fork Length, Weight and Condition Factor of Age 3.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1978.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)
June 3 - 9	3	1.5	178.7 \pm 6.1	56.97 \pm 1.03	1.00
June 10 - 16					
June 17 - 23	3	0.4	191.7 \pm 3.8	66.93 \pm 3.41	0.95
June 24 - 30	1	0.3	193	70.3	0.98
July 1 - 7					
July 8 - 14					
July 15 - July 21					
July 22 - July 28	1	6.7	208	83.1	0.92

Table 7. Relative Abundance and Timing of Age 1.0, 2.0 and 3.0 Bear Lake Coho Salmon Smolts Emigrating to Bear Creek Weir, 1978.

Weekly Periods	Number of Smolts**			Total
	Age 1.0	Age 2.0	Age 3.0	
May 27 - June 2*	112	45	2	159
June 3 - 9	7,113	2,868	152	10,133
June 10 - 16	27,258	6,435		33,693
June 17 - 23	19,995	3,601	95	23,691
June 24 - 30	14,464	2,582	51	17,097
July 1 - 7	8,533	682		9,215
July 8 - 14	1,630	119		1,749
July 15 - 21	924	42		966
July 22 - 28	577		41	618
July 29 - August 4	142	29	1	172
August 5 - 11	7	1		8
August 12 - 18	68	14		82
August 19 - 25	32	7		39
August 26 - Sept. 1	2			2
Sept. 2 - 8				
Sept. 9 - 15	157	32	1	190
Total	81,014	16,457	343	97,814
Percent	82.8	16.8	0.4	100.0

* Includes 21 smolts captured in previous two weeks. Age composition is based on June 3 - 9 weekly sample.

** Number of smolts per age group after week of July 22 - 28 is estimated by overall age composition determined up to that point.

The 343 age 3.0 smolts resulted from the fourth fingerling plant (450,000 age 0.0 fingerlings in 1975) in Bear Lake following the 1971 lake rehabilitation project. Bear Lake coho fingerling plants since 1973 are summarized in Table 8, and smolt production since 1975 is presented in Table 9. Total fingerling-to-smolt survival for the 1975 plant was 25.1%, or 2.6 times that of the previous plant. This increased survival resulted due to the substantial reduction in Bear Lake's juvenile coho rearing densities beginning in 1976. Age composition of the fourth Bear Lake smolt production cycle was 56.8% age 1.0, 42.9% age 2.0, and 0.3% age 3.0.

The 16,457 age 2.0 smolts were produced from 224,600 age 0.0 fingerling stocked in 1976. With the 49,752 age 1.0 smolts which emigrated in 1977; 29.5% of that plant has survived to smolts thus far. Since electrofishing of Bear Lake's residual coho population was not conducted in the fall of 1978, the relative abundance of age 2.0 fingerlings is not known. Therefore, the magnitude of the age 3.0 smolt out-migration resulting from this plant is unpredictable. Except for the age 3.0 smolts anticipated in 1979, age composition of Bear Lake's fifth smolt production cycle was 75.1% age 1.0 and 24.9% age 2.0.

The 81,014 age 1.0 smolts resulted from the sixth annual Bear Lake plant of 227,700 age .0 fingerlings in 1977. This was the second fingerling release made since 1972 with reduced stocking density (Table 8). Fingerling-to-smolt survival of this age group was 35.6%, which is the highest percentage realized since 1971 of any Bear Lake fingerling plant resulting in yearling smolts. It is anticipated that total fingerling-to-smolt survival of this plant will exceed 50%.

Age 1.0 smolts not only were the most abundant but also the second largest fish in their age group ever to emigrate Bear Lake in the project's history. It is noted, however, that they resulted from fingerlings averaging 644/kg (292/lb) or approximately 51 mm in fork length when stocked (Table 8). Fingerlings stocked prior to 1976 were considerably smaller, ranging from 35 mm to 41 mm.

Age 1.0 smolts averaged 120.0 mm and 16.89 g for a condition factor (K) of 0.98 at peak of migration, June 17-23. This age group in October, 1977, (age 0.0 fingerlings) averaged 93.4 mm in the Bear Lake electrofishing population sample (n = 590). Therefore, these fish grew nearly 27 mm during the winter-early spring months before migrating as age 1.0 smolts. Although age 0.0 fingerlings comprised 97.8% of that sample, resultant age 1.0 smolts composed 82.8% of the 1978 smolt out-migration. Weighted K of age 1.0 smolts for the June 3-July 28 sampling period was 0.97, compared to 1.02 in 1977.

Age 2.0 smolts averaged 134.8 mm and 24.12 g for a K = 0.98 at migration peak, June 10-16. This age group in October, 1977, (age 1.0 fingerlings) averaged 124.5 mm, so increased an additional 10 mm over winter. Age 1.0 fingerlings comprised only 2.0% of the fall population sample, but 16.8% of the 1978 smolt out-migration. Weighted K of age 2.0 smolts was 0.98, identical to that in 1977.

Table 8. Summary of Bear Lake Coho Salmon Fingerling Plants, 1973-1978

Brood Year	Source of Eggs	Number of Fish	Weight		Size		Density		Dates of Plants	+ Planting Method
			lbs.	kg.	No./lb	No./kg	No./acre	No./ha		
1972	Bear Lake	96,900	113	51.3	857	1,889	218	538	June 19	Truck-boat
	Lake Rose Tead*	<u>346,400</u>	<u>538</u>	<u>244.0</u>	<u>644</u>	<u>1,419</u>	<u>778</u>	<u>1,922</u>	June 20	Scattered
	Total**	<u>443,300</u>	<u>651</u>	<u>295.3</u>	<u>681</u>	<u>1,501</u>	<u>996</u>	<u>2,460</u>	1973	
1973	Upper Station*	240,900	476	215.9	506	1,115	541	1,337	July 15	Truck-boat
	Upper Station*	200,900	416	188.7	483	1,064	452	1,115	July 16	Scattered
	Upper Station*	<u>9,000</u>	<u>29</u>	<u>13.2</u>	<u>310</u>	<u>683</u>	<u>20</u>	<u>50</u>	July 16	
	Total**	<u>450,800</u>	<u>921</u>	<u>417.8</u>	<u>489</u>	<u>1,078</u>	<u>1,013</u>	<u>2,502</u>	1974	
1974	Bear Lake	245,600	454	205.9	541	1,192	552	1,363	June 19	Aircraft
	Bear Lake	<u>204,400</u>	<u>455</u>	<u>206.4</u>	<u>449</u>	<u>989</u>	<u>459</u>	<u>1,135</u>	July 1	Scattered
	Total**	<u>450,000</u>	<u>909</u>	<u>412.3</u>	<u>495</u>	<u>1,091</u>	<u>1,011</u>	<u>2,498</u>	1975	
1975	Bear Lake	149,800	433	196.4	346	763	357	832	June 10	Aircraft
	Bear Lake	<u>74,800</u>	<u>185</u>	<u>83.9</u>	<u>405</u>	<u>893</u>	<u>168</u>	<u>415</u>	June 14	Scattered
	Total**	<u>224,600</u>	<u>618</u>	<u>280.3</u>	<u>363</u>	<u>800</u>	<u>505</u>	<u>1,247</u>	1976	
1976	Bear Lake	<u>227,700</u>	<u>780</u>	<u>353.8</u>	<u>292</u>	<u>644</u>	<u>512</u>	<u>1,264</u>	June 16	Truck-boat
									1977	Scattered
1977	Bear Lake	157,000	457	207.3	345	757	353	871	June 20	Truck-boat
		<u>68,800</u>	<u>216</u>	<u>98.0</u>	<u>320</u>	<u>705</u>	<u>154</u>	<u>382</u>	June 21	Scattered
	Total	<u>225,800</u>	<u>673</u>	<u>305.3</u>	<u>337</u>	<u>743</u>	<u>507</u>	<u>1,255</u>	1978	

* These systems are located on Kodiak Island.

** Weighted averages.

Table 9. Summary of Bear Lake Coho Salmon Smolt Abundance and Biomass Produced since 1975 from Annual Fingerling Plants, 1974-1977.

Year of Plant	No. of Fingerlings and Weight (kg)	Smolt Production by Year				Total Production	Survival to Smolt (%)
		1975	1976	1977	1978		
<u>1974</u>							
Number	450,800	13,487	28,211	1,686		43,384	9.6
Weight (kg)	418.1	155.9	1,029.5	94.1		1,279.5	
Weight Ratio		0.4:1	2.5:1	0.2:1		3.1:1	
<u>1975</u>							
Number	450,000		64,083	48,393	393	112,819	25.1
Weight (kg)	412.7		915.6	1,050.6	22.5	1,988.7	
Weight Ratio			2.2:1	2.5:1	0.1:1	4.8:1	
<u>1976</u>							
Number	224,600			49,752	16,457	66,209	29.5*
Weight (kg)	280.3			795.5	424.0	1,219.5	
Weight Ratio				2.8:1	1.5:1	4.4:1	
<u>1977</u>							
Number	227,700				81,014		35.6**
Weight (kg)	353.8				1,422.8		
Weight Ratio					4.0:1		

* Includes only age 1.0 and 2.0 smolt production.

** Includes only age 1.0 smolt production.

Bear Lake's estimated smolt biomass production was 70.9 kg lower than in 1977, which was 76.6 kg below 1976. Using 1976 as a reference point, Bear Lake's yield has decreased approximately 7,630 smolts (averaging 19.33 g in 1977 and 1978 combined) due to the 147.6 kg loss in biomass production. The reasons for this slight but continuing decline are unknown, although it may be related to the drastic reduction in Bear Lake's sockeye salmon production since 1970.

Bear Lake was restocked on June 20-21, 1978 with 225,800 age 0.0 coho fingerlings (1977 brood, Bear Lake origin) averaging 743/kg. (337/lb) to maintain smolt production.

Other Species:

The total sockeye salmon smolt out-migration enumerated from the trap was 11,952 fish. Trap mortality claimed only eight smolts, or 0.1% of the downstream migration. The first smolt was captured on May 17, and the last on July 26. The highest daily count occurred on May 29 when 1,403 smolts (11.7% of the migration) were enumerated. The majority (80.1%) emigrated between May 20 and June 19, when water temperatures ranged from 3.8°C to 11.7°C (39°F-53°F) and stream flows, from 37 to 65 cfs. The smolt out-migration was comprised of 11,678 (97.7%) age 1.0, 248 (2.1%) age 3.0, and 26 (0.2%) age 4.0 smolts. Age 4.0 smolts resulted from the 1973 escapement of 145 females and 91 males, including the 1,044 age 1.0, 868 age 2.0, and 573 age 3.0 smolts which emigrated in 1975, 1976, and 1977 respectively, the total smolt production was 2,511 smolts (17.3 per female) for the second, post-rehabilitation sockeye escapement into Bear Lake. Age 3.0 smolts were produced by the 36 females and 24 males that spawned in 1974. With the 6 age 1.0 and 284 age 2.0 smolts resulting in 1976 and 1977, a total of 538 smolts (14.9 per female) were produced by this parent brood. No age 2.0 smolts were produced due to only seven jacks returning to Bear Lake in the 1975 escapement (Bear Lake produced no sockeye smolts in 1972-1973 because of the 1971 lake rehabilitation). Age 1.0 smolts resulted from the 271 females and 307 males in the 1976 Bear Lake escapement. Age 1.0 and 3.0 smolts peaked during May 27-June 2, while age 4.0 smolts delayed emigration until June 17-23. At peak of migration, age 1.0, 3.0, and 4.0 smolts averaged 108.1, 182.2, and 227.0 mm, respectively. Condition factors per age group during migration peaks were 1.04 (age 1.0), 0.99 (age 3.0) and 0.88 (age 4.0).

A total of 212 Dolly Varden were captured in the downstream trap and released below the weir. No threespine sticklebacks were caught in the trap nor observed in Bear Lake.

Resurrection Bay Coho Salmon Harvest and Effort:

A stratified, random creel census to determine the Resurrection Bay coho sport harvest and effort was initiated at the Seward small boat harbor on July 8 and terminated September 10. Very few coho were taken before the creel census began since most sport fishing effort was directed toward the more abundant rockfish, *Sebastes* spps., from mid-May through early July.

The season's total harvest was an estimated 15,550 coho. This estimate was extrapolated from interviews with 5,352 anglers harvesting 3,587 coho during the creel census period. Peak of the harvest occurred on August 13, second day of the Seward Silver Salmon Derby, when an estimated 1,258 fish (8.1% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1974 through 1978 in Table 10.

Marked adult coho contributed 34.6%, or an estimated 5,386 fish, to the 1978 Resurrection Bay sport harvest. With the 1,319 unmarked Bear Lake adults estimated (by applying the 0.58:1 catch-to-escapement ratio of marked Bear Creek returns to the unmarked Bear Creek escapement) in the harvest, the total contribution of enhanced adult coho production was 6,705 fish, or 43.3% to the sport fishery.

The major source (51.3%, or 3,442 RV adults) of the enhanced coho catch resulted from 100,450 hatchery-reared and marked smolts stocked in Seward Lagoon in May, 1977. The second most abundant contribution, (30.4%, or 2,035 adults) survived from 99,844 Bear Lake smolts (25% Ad-LV marked) and 35,100 Ad-RV marked, hatchery smolts released in Bear Creek in 1977. The remaining 18.3%, or 1,228 LV adults returned from 35,100 hatchery smolts planted in Grouse Lake in May, 1977.

In addition to the marked adult harvest, an estimated 63 Ad-CWT marked immatures and jacks contributed 0.4% to the sport catch. These fish resulted from the 25% Ad-CWT marked segment of 126,000 age 1.0 (1976 brood Bear Lake origin) hatchery-reared smolts stocked in Seward Lagoon, 50% Ad-CWT portion of 53,500 smolts (same age and origin) released in Grouse Lake, and 95% Ad-CWT marked component of 28,600 smolts planted in lower Bear Creek in late May-early June, 1978. Age 1.1 Ad-CWT and unmarked adults surviving from these smolt releases will return in 1979.

The total sport fishing effort exerted for Resurrection Bay coho was an estimated 22,291 man-days. Twenty-four percent of the season's effort was sampled during the creel census period. The mean number and percentage of sport fishing boats returning daily to the Seward small boat harbor are shown in Table 11. The average number of anglers per boat was as follows: weekdays, 3.13; weekends, 3.24; and the salmon derby, 3.12. Fishing effort and mean seasonal catch per hour are summarized in Table 12. The fishing effort was 5,750 man-days on weekdays and 6,477 on weekends, excluding the derby. Military personnel and dependents, fishing on boats provided by the Army and Air Force recreation camps at Seward, contributed 8.8% (1,969 man-days) to the total effort. The seasonal mean catch per hour was 0.126 coho. Civilian anglers fishing on weekdays realized the highest coho catch per hour (0.175), whereas the lowest catch rate (0.106) occurred during weekends when effort was more intense. The average number of hours anglers fished per day were as follows: weekdays, 5.18; weekends, 4.78; and salmon derby, 6.26.

Examination of 377 scale samples randomly collected throughout the sport fishery disclosed that the unmarked "wild" coho population was comprised of 68.0% age 1.1, 27.3% age 2.1, and 4.7% age 3.1 adults. This age

Table 10. Derby and Total Sport Harvest of Coho Salmon in Resurrection Bay, 1974-1978.

Year	Total Sport Harvest	Derby Harvest	% Derby Harvest
1974	18,629	5,646	30.3
1975	19,793	3,799	19.2
1976	9,456	2,708	28.6
1977	16,345	6,007	36.8
1978	15,550	7,258	46.7

Table 11. Mean Number and Percentage of Sport Fishing Boats Returning to the Seward Small Boat Harbor During Each Sampling Period, 1978.

Periods (hours)	Weekends		Weekdays	
	Mean No. of Boats	Percent	Mean No. of Boats	Percent
8:00 a.m. - 11:30 a.m.*	15.4	11.6	6.0	14.3
11:30 a.m. - 3:00 p.m.	27.0	20.3	9.9	23.5
3:00 p.m. - 6:30 p.m.	60.8	45.7	14.4	34.3
6:30 p.m. - 10:00 p.m.	<u>29.9</u>	<u>22.4</u>	<u>11.7</u>	<u>27.9</u>
Total	133.1	100.0	42.0	100.0

* Percentage for this period determined by three-year mean, 1964-1966.

Table 12. Derby and Total Sport Effort (Man-Days) Exerted for Coho Salmon and Mean Catch Per Hour in Resurrection Bay, 1974-1978.

Year	Period of Census	Total Effort	Derby Effort	% Derby Effort	Catch Per Hour
1974	July 2 - Sept. 9	25,902	10,225	39.5	0.109
1975	July 9 - Sept. 7	20,047	5,871	29.3	0.135
1976	July 8 - Sept. 12	19,681	8,421	42.8	0.084
1977	July 9 - Sept. 7	23,997	9,121	38.0	0.113
1978	July 8 - Sept. 10	22,291	10,064	45.1	0.126

composition is similar to that of the 1977 sample (70.6% age 1.1, 27.4% age 2.1, and 2.0% age 3.1 fish; McHenry, 1978). It should be noted, however, that unmarked Bear Lake coho comprised 13.1% of the total unmarked adult catch, and probably entered the above sample at a similar frequency. Since smolt survival differentiation between returning age 1.1, 2.1, and 3.1 unmarked adults is not monitored at Bear Creek weir, the extent of age composition skewing of the wild population sample by the latter is unknown. Age composition of the 1977 unmarked Bear Lake coho smolt emigration was 49.8% age 1.0, 48.4% age 2.0, 1.7% age 3.0, and 0.1% age 4.0. The dominant age class of wild Resurrection Bay coho populations has changed from age 2.0 (4-year-old) to age 1.1 (three-year-old) fish since 1975. Table 13 shows the age composition trend since 1972. Mean fork lengths and weights of wild coho are presented in Table 14. The male-to-female sex ratio was 1.1:1 in the sport fishery.

An estimated 610 chinook salmon were harvested during the census period at an average rate of 0.15 per boat. This species was most abundant during mid-July when anglers averaged 0.31 fish per boat. Most chinook taken were immature fish in their first and second ocean years. Origins of these stocks are unknown as chinook rarely ascend Resurrection Bay streams. No age 0.2 jacks resulting from 25,100 LV marked smolts released in Box Canyon Creek in 1976, nor any age 0.1 jacks from 50,000 RV marked smolts stocked in that tributary in 1977 were observed either during creel census or on three Box Canyon Creek foot surveys conducted from July 11 to August 29. Age 0.3 adults from the 1976 lot, age 0.2 jacks from the 1977 release, and age 0.1 jacks from the 1978 plant (150,500 smolts, 25% marked Ad-CWT) are expected to return in 1979.

The Resurrection Bay pink salmon return in 1978 evidently was nearly as large as that in 1970 when an estimated 3,784 were taken in the sport fishery. The estimated pink salmon harvest in 1978 was 3,367 fish. A 24-hour commercial purse seine fishery held on August 7 harvested approximately 30,000 pink salmon by ten seine boats. Pink salmon were most abundant in the sport fishery from late July through early August when anglers averaged 1.31 fish per boat. Pink salmon catch per man-day averaged 0.36 in 1978 compared to 0.39 in 1970.

Adult Coho Timing and Abundance in Index Streams:

Peak of the 1978 index escapements ranged from October 14 to November 13, and peak of spawning generally occurred within the following two weeks in these index areas. Estimated minimum escapements of wild coho in each stream index area since 1974 are presented in Table 15. As noted previously (McHenry, 1978), straying of marked, hatchery-reared smolt releases (including marked Bear Lake smolts) observed in most index streams is considered insignificant relative to the total return of each lot.

The total combined index escapement of 708 wild adults is nearly seven times the magnitude of the 1975 parent brood escapement which mainly produced it, and twice the abundance of the previous cycle (1974-1977)

Table 13. Age Composition of Wild Resurrection Bay Coho Salmon Populations 1972-1978.

Year	Sampling Period	No. of Fish	Age Composition			Total
			1.1	2.1	3.1	
1972	July 4 - Sept. 4	179	34.7	59.2	6.1	100.0
1973	July 7 - Sept. 2	201	42.8	49.7	7.5	100.0
1974	July 2 - Sept. 1	236	49.1	49.2	1.7	100.0
1975	July 9 - Sept. 11	250	58.0	35.2	6.8	100.0
1976	July 8 - Sept. 3	213	77.0	21.6	1.4	100.0
1977	July 9 - Sept. 7	303	70.6	27.4	2.0	100.0
1978	July 8 - Sept. 10	377	68.0	27.3	4.7	100.0

Table 14. Mean Fork Length (mm) and Weight (kg) of Wild Adult Coho Salmon Sampled From the 1978 Resurrection Bay Sport Fishery.

	Number of Fish	Mean Length (mm) and SD	Mean Weight (kg) and SD
Males	198	677.1 \pm 56.4	4.42 \pm 1.07
Females	179	655.0 \pm 42.7	3.91 \pm 0.91
Total	377	666.6 \pm 51.5	4.18 \pm 1.03

Table 15. Minimum Wild Coho Salmon Escapement in Seven Index Streams in the Resurrection Bay Area, 1974 - 1978.

Name of Stream	Minimum Escapement					Mean 1974-1977
	1974	1975	1976	1977	1978	
Airport	23	2	24	7	14	14
Box Canyon	28	8	45	45	28	32
Clear	60	15	89	37	59	50
Dairy	114	32	17	134	146	74
Grouse	64	12	27	187	360	73
Jap	77	31	94	62	51	66
Mayor	<u>51</u>	<u>5</u>	<u>46</u>	<u>42</u>	<u>50</u>	<u>36</u>
Total	417	105	342	514	708	345

mean. However, it is noted that the Grouse Creek escapement of 360 wild coho was about five times its previous cycle mean, and was mainly responsible for the greatly increased total escapement.

Bear Lake Upstream Migration:

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through October 31. The first adult coho entered the trap on September 2 and the last one was captured October 31. An estimated 474 coho spawned below the weir according to foot surveys made after the adult run had entered the trap.

A total of 2,959 adults and 130 jacks were enumerated from the trap. Abundance and timing of the adult coho migration are shown in Table 16. Weekly breakdown of the adult migration by release lot is presented in Table 17.

The adult migration peaked (50%) on October 4, and the highest daily count of 351 fish (11.9% of the adult run) occurred on October 7. Mean stream temperatures at the beginning, peak, and end of migration were 13.3°C (56.0°F), 8.1°C (46.5°F) and 4.2°C (39.5°F), respectively. Most of the migration (89.1%) occurred from September 16 through October 20 when Bear Creek temperatures ranged from 6.1°C to 11.7°C (43°F-53°F) and flows, from 11 cfs to 150 cfs.

Since no Ad (only) marked smolts were released in Bear Creek in 1977, the 127 Ad adults returning in 1978 (Table 17) resulted from ventral fin regeneration in the Ad-RV and Ad-LV lots. The 127 Ad fish, therefore, were apportioned to those groups on the basis of their relative abundance at the weir (79.5% Ad-RV vs. 20.5% Ad-LV). This assumes that both lots experienced equal ventral fin regeneration. Time did not permit measuring ventral fins of Ad marked fish or recording ventral fin abnormalities on Ad-RV and Ad-LV fish. Table 18 shows the various components comprising total adult returns of Bear Lake, Bear Creek, Grouse Lake and Seward Lagoon coho production from 1977 smolt releases.

An estimated 649 Ad-RV coho (548 + 101 Ad) returned to the weir. With the additional 176 (156 + 20 Ad) that spawned below the weir and 150 which strayed into local streams, the total Ad-RV coho escapement was an estimated 975 fish. Including the 687 (650 + 37 Ad) estimated taken in the Resurrection Bay boat harvest and 47 taken during the beach fishery, the total return was 1,709 Ad-RV coho. These adults resulted from 35,100 age 1.0 (1975 brood, Bear Lake origin) smolts marked at Fort Richardson and released by Hatchery Services in Bear Creek below the weir on May 13-15, 1977. Total smolt-to-adult survival of this release lot was 4.9%.

An estimated 173 Ad-LV coho (147 + 26 Ad) ascended Bear Creek to the weir, and an additional 40 (35 + 5 Ad) spawned in lower Bear Creek. The total Ad-LV escapement, therefore, was an estimated 213 coho. With the 29 (27 + 2 Ad) estimated caught in the boat fishery, the total Ad-LV return was 242 fish. These coho resulted from 24,961 age 1.0, 2.0, and 3.0 Bear Lake smolts marked and released at Bear Creek weir in 1977. Total survival of this group was only 1.0%.

Table 16. Bear Lake Adult Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1978.

Weekly Periods	Marked	Unmarked*	Male	Female	Total
Sept. 2 - 8		6	6		6
Sept. 9 - 15	27	146	148	25	173
Sept. 16 - 22	154	712	542	324	866
Sept. 23 - 29	74	302	204	172	376
Sept. 30 - Oct. 6	125	366	316	175	491
Oct. 7 - 13	235	336	335	236	571
Oct. 14 - 20	158	174	174	158	332
Oct. 21 - 27	66	71	77	60	137
Oct. 28 - Nov. 3	<u>3</u>	<u>4</u>	<u>3</u>	<u>4</u>	<u>7</u>
Total	842	2,117	1,805	1,154	2,959

* Seventy-five percent of the 1977 smolt out-migration were released unmarked to enhance smolt-to-adult survival.

Table 17. Marked Adult Coho Salmon Enumerated through Bear Creek Weir by Weekly Periods, 1978.

Weekly Periods	Mark (Fin-clip)*					Total
	Ad-RV	Ad-LV	Ad	LV	RV	
Sept. 2 - 8						
Sept. 9 - 15	8	5	14			27
Sept. 16 - 22	48	50	52		4	154
Sept. 23 - 29	27	27	17	3		74
Sept. 30 - Oct. 6	86	22	16	1		125
Oct. 7 - 13	195	17	18	3	2	235
Oct. 14 - 20	125	21	8	2	2	158
Oct. 21 - 27	56	5	2	3		66
Oct. 28 - Nov. 3	<u>3</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>3</u>
Total	548	147	127	12	8	842

* Ad-RV (adipose-right ventral) - 1977 Bear Creek smolt release
 Ad-LV (adipose-left ventral) - 1977 Bear Lake smolts marked (25%) at weir
 Ad (adipose only) - resulting from ventral fin regeneration of above marks
 LV (left ventral) - 1977 Grouse Lake smolt release
 RV (right ventral) - 1977 Seward Lagoon smolt release

Table 18. Total Adult Return Components of Bear Lake, Bear Creek, Grouse Lake and Seward Lagoon Enhanced Coho Salmon Production from 1977 Smolt Releases.

<u>Water Body and Fin Mark</u>	<u>Boat Harvest</u>	<u>Beach Harvest</u>	<u>Escapement</u>	<u>Below Weir</u>	<u>Strays</u>	<u>Total Return</u>	<u>Smolt- to-Adult Survival (%)</u>
Bear Creek	650 + 37 Ad*	47	548 + 101 Ad**	156 + 20 Ad**	150	1,709	4.9
Bear Lake							
Ad-LV	27 + 2 Ad*		147 + 26 Ad**	35 + 5 Ad**		242	1.0
Ad(only)	39		127	25		191	
UNM***	1,319	...	2,117	157		3,593	4.8
Grouse Lake							
LV	1,228	68	906		102	2,304	6.6
Seward Lagoon							
RV	3,442	3,057	1,088		123	7,710	7.7

* The 39 Ad coho were apportioned to the Ad-RV and Ad-LV coho caught on the basis of their relative abundance in the harvest: 96.0% Ad-RV vs. 4.0% Ad-LV.

** The 152 Ad coho were apportioned to the Ad-RV and Ad-LV lots based on their relative abundance in the Bear Creek escapement: 79.5% Ad-RV vs. 20.5% Ad-LV.

*** Boat harvest of unmarked Bear Lake coho was estimated by applying the 0.58:1 catch-to-escapement ratio of marked Bear Creek fish to the 2,274 unmarked Bear Creek escapement. Contribution of unmarked Bear Lake coho to the 431 wild coho taken in the beach fishery was unknown but probably negligible due to the few Ad-RV and LV marked fish observed in the harvest.

In contrast, an estimated 3,593 unmarked Bear Lake coho survived from 74,883 smolts released unmarked past the weir in 1977. Total smolt-to-adult survival of this lot, therefore, was estimated at 4.8%, nearly identical to that of the Ad-RV despite the size differential at release. Ad-RV smolts averaged 43.2 g (10.5/lb) compared to 19.7 g (23.1/lb) mean weight of Bear Lake smolts in 1977. Unmarked Bear Lake smolts realized about five times the survival of their marked counterparts.

Although it is recognized that some of the unmarked Bear Creek coho probably resulted from natural smolt production in lower Bear Creek, the vast majority of these adults are believed to have survived from the aforementioned Bear Lake smolt release.

The 12 LV and 8 RV coho enumerated from the trap, plus 81 LV and 20 RV fish that spawned below the weir, strayed from the 1977 smolt releases in Grouse Lake and Seward Lagoon, respectively. Although local straying of adult coho from Seward area smolt releases has been noted in recent years, incidence of this phenomenon is relatively insignificant. In 1978, straying accounted for only 0.01% to 0.4% of any release lot.

Mean fork length and weight of adult coho sampled at the weir are presented in Table 19. The male-to-female sex ratio, excluding jacks, was 1.6:1 in the Bear Creek escapement.

Most (82.3%) of the jack coho migration resulted from 107 prematurely returning Ad-CWT marked, hatchery-reared smolts released in Bear Creek below the weir. These fish (27,156) were age 1.0 (1976 brood, Bear Lake origin) and averaged 45.0 g (10/lb) on May 31, 1978 when stocked. Most of the 23 unmarked jacks captured probably returned from an additional 1,418 unmarked smolts released with the above plant, since they were the same size at release. The 73,232 Bear Lake smolts released unmarked in 1978 were substantially smaller (19.0 g or 24/lb) than the hatchery-reared smolts and likely contributed few if any of these jacks. In 1977 only six jacks returned from 74,883 unmarked Bear Lake smolts averaging 19.7 g (23/lb) at release.

Coho Salmon Egg-Takes:

Most of the Department's coho egg requirements for the Southcentral region's needs were obtained from the Bear Creek adult return. A total of 143 males and 781 females were held to ripen in the Bear Creek holding facility from September 9 to November 2. Stream temperatures ranged from 3.3°C to 13.9°C (38°F-57°F) during this period. Male and female holding mortalities were 15.4% and 36.5%, respectively.

A total of 496 females and 121 males were artificially spawned, yielding an estimated 2,180,760 eggs. Mean fecundity was 4,397 eggs per female. Eggs were fertilized at an average ratio of 1 male:4 females. Dead egg loss after shocking at Fort Richardson Hatchery averaged 4.3% (Heidy personal communication). All spawned carcasses were deposited in Bear Lake for natural fertilization.

Table 19. Mean Fork Length (mm) and Weight (kg) of Adult Coho Salmon Sampled at Bear Creek Weir in 1978.

Lot	Males			Females			Sexes Combined		
	No.	FL	Wt.	No.	FL	Wt.	No.	FL	Wt.
Ad-RV	85	673.4	3.62	50	699.6	4.12	135	683.1	3.81
Ad-LV	25	659.8	3.26	18	651.2	3.50	43	656.2	3.36
Ad (only)	17	652.0	3.54	9	661.2	3.81	26	655.2	3.64
LV	3	636.3	2.72	1	634	3.18	4	635.8	2.83
RV	1	681	3.67				1	681	3.67
Unmarked	<u>279</u>	<u>655.0</u>	<u>3.42</u>	<u>199</u>	<u>656.4</u>	<u>3.71</u>	<u>478</u>	<u>655.6</u>	<u>3.54</u>
Total	410	658.9	3.45	277	663.9	3.77	687	660.9	3.57

Other Species:

Only 27 adult sockeye salmon ascended Bear Creek to the weir in 1978. Of the 17 fish sampled (63.0% of the run), 14 were two-ocean and 3 three-ocean adults, as determined by scale analysis. Mean fork lengths of the two- and three-ocean sockeye were 558.6 mm and 647.3 mm. The estimated 16 age 2.2 adults (58.8% of the sample) in the escapement represents only 1.8% smolt-to-adult survival of the 868 age 2.0 smolts that emigrated Bear Lake in 1976. This very low survival of Bear Lake sockeye smolts was similar to that (2.9%) for Bear Lake coho smolts emigrating in 1976 and returning in 1977. The electrical ground problem which prevented adult sockeye from migrating into the trap in 1977 (McHenry, 1978) probably was sufficiently severe by 1976 to cause high smolt mortalities in lower Bear Creek.

Pink salmon first entered the trap in late July, and eventually moved downstream to spawn from mid-August to mid-September. An estimated 10,000 pink salmon spawned in lower Bear Creek in 1978 (Kyle, personal communication).

Upstream migrating Dolly Varden ascended Bear Creek to the weir in early July and continued moving in and out of the trap throughout the remaining field season.

All fish species other than sockeye or coho salmon were retained below the weir.

Enhanced Coho Salmon Production:

Fin-marked coho spawning escapements bound for Seward Lagoon, Grouse and Bear Creeks were estimated at 4,268 RV, 1,076 LV, and 1,235 Ad + adults, respectively. These escapements include 3,057 RV, 68 LV, and 47 Ad-RV coho estimated taken in the shore fishery after the Resurrection Bay sport trolling effort terminated.

Total smolt survival for Seward Lagoon coho, including 1,622 age 1.0 RV marked immatures and jacks estimated caught in 1977, was 9.3%. With the 446 LV marked, immature coho estimated taken in 1977, total smolt survival of the Grouse Lake smolt plant was 7.8%. Total smolt survival of the Bear Creek smolt release, including 436 Ad-RV marked immatures estimated in 1977, was 6.1%. Overall smolt-to-adult survival of marked and unmarked Bear Lake smolts was 3.8%. Summaries of total survivals for Bear Lake, Bear Creek, and Seward Lagoon smolt releases are presented in Tables 20, 21 and 22.

The overall catch-to-escapement ratio of marked Seward Lagoon, Grouse and Bear lakes adult coho returns was 0.82:1.

DISCUSSION

The former decline in Bear Lake's coho smolt production due to overstocking its fingerling rearing environment from 1972 to 1975 was previously discussed (McHenry, 1977).

Table 20. Survival of Bear Lake Coho Salmon Adults from Seaward Migrations of Smolts Fin Marked at Bear Creek Weir, 1973-1977.

Seaward Migration Year	Number of Smolts Released	Age Composition of Out-Migration	Mean Fork Length (mm)	Fin-clip Used	Number of Adults Returning*	Percentage Return
1973	76,652	100.0% - age 1.0	107.5	Ad	5,040	6.58
1974	62,698 8,067 <u>70,765</u>	88.6% - age 1.0 11.4% - age 2.0	117.8 147.6	Ad Ad	1,762	2.49
1975	11,532 131,180 877 <u>143,589</u>	8.0% - age 1.0 91.4% - age 2.0 0.6% - age 3.0	107.3 129.2 150.7	Ad Ad Ad	1,603	1.12
1976	63,674 28,031 1,010 <u>92,715</u>	68.7% - age 1.0 30.2% - age 2.0 1.1% - age 3.0	106.3 134.9 161.0	Ad-RV Ad-RV Ad-RV	2,674	2.88
1977**	49,689 48,332 1,684 139 <u>99,844</u>	49.8% - age 1.0 48.4% - age 2.0 1.7% - age 3.0 0.1% - age 4.0	113.1 129.5 182.8 192.0	Ad-LV Ad-LV Ad-LV Ad-LV	3,835	3.84

* Includes boat and shore sport harvest estimates.

** Marked only 25.0% of out-migration.

Table 21. A Summary of Hatchery Reared Coho Salmon Smolt Releases in Lower Bear Creek.

Brood Year	Origin	Mark	Smolt Liberation Data			Adult Return Data*				Total Number	Return Percent
			Release Date	Number	Fish/kg. (lb.)	0+ No.	Ocean(jacks) %	1-Ocean No.	%		
1967	Oregon	Ad	5/8-13/69	47,470	30.4 (13.8)	8	0.02	17	0.04	25	0.05
1968	Bear Lake	Ad	5/27/70	6,400	22.7 (10.3)	76	1.19	285	4.45	361	5.64
1969	Bear Lake	Ad	5/18-21/71	51,100	31.3 (14.2)	14	0.03	178	0.35	192	0.38
1970	Kodiak	Ad	5/15-24/72	155,500	32.6 (14.8)	155	0.10	470	0.30	625	0.40
1974	Bear Lake	Ad-LV	5/12-14/76	35,600	25.1 (11.4)	16	0.05	756	2.12	772	2.17
1975	Bear Lake	Ad-RV	5/13-15/77	35,100	23.1 (10.5)	436	1.24	1,709	4.87	2,145	6.11

* Includes boat and shore sport harvest estimates.

Table 22. A Summary of Hatchery Reared Coho Salmon Smolt Releases in Seward Lagoon.

Brood Year	Origin	Smolt Liberation Data				0+ Ocean(jacks)		1-Ocean		Total Number	Return Percent
		Mark	Release Date	Number	Fish/kg.(lb.)	No.	%	No.	%		
1966	Oregon	Ad	4/18-22/68	42,200	40.1 (18.2)	0	0.00	15	0.04	15	0.04
1967	Oregon	Ad	5/6-7/69	27,100	32.2 (14.6)	1	0.00	6	0.02	7	0.03
1968	Bear Lake	Ad	5/19-27/70	39,750	23.8 (10.8)	952	2.39	5,114	12.87	6,006	15.11
1969	Bear Lake	Ad	5/17/71	10,900	31.3 (14.2)	3	0.03	1,519	13.94	1,522	13.96
1970	Kodiak	Ad	5/31/72	66,500	37.0 (16.8)	915	1.38	2,963	4.46	3,878	5.83
1971	Seward Lagoon	Ad-LV	5/7-9-73	30,200	19.6 (8.9)	140	0.46	125	0.41	265	0.88
1972	Kodiak	Ad-RV	5/6-11/74	100,000	20.7 (9.4)	4,764	4.76	3,885	3.89	8,649	8.65
1973	Seward Lagoon	Ad-LV	5/15-19/75	100,700	20.1 (9.1)	2,610	2.59	1,971	1.96	4,581	4.55
1974	Bear Lake	LV	5/4-10/76	100,600	28.2 (12.8)	600	0.60	4,513	4.49	5,113	5.08
1975	Bear Lake	RV	5/6-13/77	100,450	27.7 (10.3)	1,622	1.61	7,710	7.68	9,332	9.29

* Includes boat and shore sport harvest estimates.

Since 1976, Bear Lake has been stocked at approximately 1,250 instead of 2,500 fingerlings per hectare with the following results: (1) Age composition of Bear Lake's juvenile standing crop in October, 1977 increased to 98% young-of-the-year (age 0.0) fingerlings, resulting in 82.8% of the 1978 smolt out-migration emigrating as yearling (age 1.0) smolts. (2) The 35.6% survival of the latter from the 1977 fingerling plant is the highest percentage realized since 1971, and it is anticipated that total fingerling-to-smolt survival of this plant will exceed 50%. (3) Smolt-to-adult survivals since 1976 have increased 270% due to healthier, more robust Bear Lake smolts going to sea. Therefore, the current Bear Lake stocking density will be maintained until findings indicate that it should be readjusted for increased smolt production in the future.

At present, it appears that Bear Lake's optimum smolt production level should be about 2,000 kg, or approximately 100,000 smolts annually. Although Bear Lake has produced nearly 100,000 smolts in each of the last two years, its total smolt biomass yields have nevertheless concomitantly declined. This suggests that Bear Lake may be deficient in one or more nutrients required to adequately maintain its food chain to sustain high smolt production levels.

It is possible that the greatly reduced sockeye salmon spawning escapements and few resultant carcasses decomposing in Bear Lake since 1970 may be having a long-term, adverse effect on the coho food chain. Foerster (1968) presented evidence from various studies on Karluk Lake, Alaska, and Lake Dalnee, Kamchatka, that seriously declining sockeye salmon escapements were at least partially responsible for reduced nutrient phosphorous levels, and hence lowered plankton reserves for juvenile sockeye production in those systems. Since overyearling coho are known predators of sockeye fry (Foerster, 1968), the virtual absence of the latter for forage might play a larger role in limiting Bear Lake's coho smolt production than heretofore expected.

It may be possible to increase Bear Lake's carrying capacity of juvenile coho via artificial fertilization. Although this concept is being considered for Bear Lake, one more year of stocking at 1,250 fingerlings per hectare is required to further define its carrying capacity under natural conditions. Once the latter has been determined to establish a control, experimentation with nutrient levels and new stocking rates may logically proceed toward evaluation.

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